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EXAMINER	
KIELIN, ERIK J	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 06/11/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/388,826	LI ET AL.	
	Examiner	Art Unit	
	Erik Kielin	2813	

-- The MAILING DATE of this c mmunication appears n the cover sheet with the c rresp ndence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 April 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *102-124,126-131 and 133-135* is/are pending in the application.

4a) Of the above claim(s) *135* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *102-124,126-131,133 and 134* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 29,
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *32,36* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 14 April 2003 has been entered.

Election/Restrictions

2. Newly submitted claim 135 is directed to an invention that is independent or distinct from the invention originally claimed for the following reasons:

The originally examined claims are drawn to forming a dielectric layer over integrated circuitry, presently classified in class 438, subclass 789. New claim 135 is drawn to forming a dielectric layer on any substrate, classified in class 427, subclass 578. The inventions are related as subcombinations, and the new claim 135 has separate utility such as forming a dielectric layer on eyeglasses. The classification is different and the search is different for the different groups.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claim 135 is withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 102-106, 108-113, 124, 126-128 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for an interlevel dielectric layer comprising carbon or and oxide comprising carbon, does not reasonably provide enablement for any material composition whatsoever.

Regarding claim 102, the specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention commensurate in scope with these claims. The specification does not provide enabling support needed for depositing all known or unknown dielectric materials or enabling support that the method of oxygen plasma treating to deposited dielectric material could be reduced by said treating. (See instant specification, section entitled, "Summary of the Invention.")

The remaining claims are rejected for depending from the above rejected claims.

5. Claims 104, 105, and 109 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Regarding claim 104, the specification does not provide support for the limitation, "wherein the blanket exposing comprises the dry oxygen-comprising gaseous material to form

the oxygen comprising plasma." There is no support to *require* the same oxygen gas used to form the dielectric layer to also be used as the oxygen source used to plasma treat the dielectric layer. There is also no support for calling the oxygen gas used to form the plasma for treating the deposited dielectric layer "dry." This is beyond the scope of the originally presented specification and is new matter.

Claim 105 is rejected for depending from claim 104.

Regarding claim 109, the specification does not provide support for *requiring* that the gas used to form the oxygen plasma for treating the deposited dielectric layer to be different from that oxygen gas used during deposition of the dielectric layer. This is beyond the scope of the originally presented specification and is new matter.

6. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

7. Claims 102-124, 126-128 and 129-131, 133, 134 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claims 102 and 129, the limitation "while generating a plasma" is unclear because the plasma has not been given a function. It is unclear is the plasma is involved in the in the deposition of the insulating layer. It is unclear if the plasma is in the deposition chamber or outside the deposition chamber. The remaining claims are rejected for depending from the above rejected claims.

Claim 115, recites the limitation, "where at least some of the carbon atoms are present within a CH_3 group." A methyl group has only 1 carbon as is clear from the formula. Several carbon atoms cannot be "present within" a single carbon atom.

Claim 120 recites the limitation, for between "at least 20 seconds to at least 100 seconds." There is no "between" because there is no upper limit.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims **102**-110, 112-124, 126-128 and **129**-131, 133, 134 are rejected under 35 U.S.C. 103(a) as unpatentable over **Yau** et al. (US 6,072,227) in view of **Morita** (JP 63-157443 A).

Yau discloses the substrate **512** (Fig. 8A) having at least partially formed integrated circuitry formed thereon; depositing thereon a low k dielectric layer **510, 518**, (which may be a liner layer, cap layer, intermetal dielectric layer, or etch stop layer; [Abstract]) using a PECVD method with precursors of, for example, methylsilane and an oxygen containing gas, such as O_2 or N_2O (col. 5, lines 35-37). Note that the dielectric layer is porous (col. 3, lines 13-29) and has a dielectric constant of less than 3.0 (**Yau**, claim 13) and in one example, a dielectric constant of 2.5 (col. 15, lines 5-18). The layer has from 1% to 50 % carbon from Si-CH_3 bonds. (See also, col. 12, line 41 to col. 13, line 52.)

Yau does not teach plasma treating the dielectric layer with oxygen plasma.

Morita discloses a very similar method to **Yau** comprising forming a low-dielectric-constant material comprising phenyl or alkyl silicon oxide **10** which inherently has a dielectric constant of less than 3.5 over an integrated circuit Fig. 2; blanket exposing the dielectric to oxygen plasma to form and upper surface 11 of silicon oxide which is inherently effective to reduce the dielectric constant. (See Figs. 1-2; page 2, lower two columns.) Note that a whole of the dielectric layer is not converted from one base to another (Applicant's claim 19) and that the $(CH_3)_xSiO_y$ remains as $(CH_3)_xSiO_y$. Note that the plasma exposure time is 10 minutes. Regarding claim 14, **Morita** forms the organic silicon oxide layer using $R_nSi(OH)_{4-n}$ wherein R is any alkyl group. Examiner repeats the unchallenged official notice that alkyl includes methyl as this is the simplest of the alkyl group members. (See Hackh's, *supra*.)

To quote from **Morita** at page 5,

> "When this semiconductor substrate 1 is exposed to an **oxygen plasma** for ten minutes, the **organic functional groups** of **organic** silicon thin film 10 **are removed** to a desired depth, transforming into a silicon oxide film. As such, the film thickness of organic silicon thin film 10 as initially formed, in its thinnest portions, transforms **nearly** entirely to silicon oxide film 11; only in the thickest portion does it come so as to have **a two-layer structure of silicon oxide film 11 and organic film 10** (figure 3)." (Emphasis added; page 5 of translation, lines 5-14).

Morita teaches that the oxygen plasma treatment solves the problem of poor insulation of the upper portion of organic spin-on glasses by removing the excess organic moieties at the surface, while beneficially preserving adhesion to the underlying layers by leaving the organic moieties in the lower portion of the film. (See translation provided by Applicant, section entitled "FUNCTION" beginning on p. 3.)

Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Yau** to carry out the plasma treatment in **Morita** for the reasons just indicated in **Morita** for carrying out the plasma treatment. As indicated the dielectric would inherently be lowered because Applicant indicates that an oxygen plasma treatment will lower the dielectric constant. This makes common sense since the organic portion removed will leave behind additional porosity in the **Yau** dielectric layer, and space has the lowest dielectric constant attainable thereby lowering the overall dielectric constant of the layer.

Regarding claim 103, **Yau** discloses O_2 and N_2O and any oxygen containing gas, as noted above.

Regarding claims 104, 105 as noted above, **Morita** teaches oxygen which is not water and is therefore, dry oxygen.

Regarding claim 106-108, **Yau** discloses nitrous oxide, N_2O.

Regarding claim 109, **Yau** discloses methyl silane and N_2O deposition, and **Yau** teaches oxygen plasma exposure.

Regarding claim 110, the stability of the dielectric layer is inherently increased for the reasons indicated in **Morita** and by Applicant.

Regarding claim 112, **Morita** teaches that the organic silicon film is cured at 450 °C and no heating appears to be indicated; therefore, the temperature during exposure must be less than 550 °C.

Regarding claim 113, the **Morita** exposure is not indicated to etch.

Regarding claims 114-115, 122, 123, and 130, both **Yau** and **Morita** make the film from at least methylsilane. **Yau** specifically indicates that the film has from 1-50% carbon arising

from Si-C bonds, preferably 20%. (col. 5, lines 12-44). Furthermore, Applicant has not indicated any criticality to the claimed portions. See In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable thereover because, among other reasons, there was *no evidence of the criticality* of the claimed ranges of molecular weight or molar proportions.). Any difference is a matter of routine optimization within prior art general conditions. (See MPEP 2144.05.)

Regarding claim 116, **Morita**, as noted above indicates that the exposure the organo dielectric leaves the organo dielectric substantially as its original composition. Since **Yau** teaches Applicant's specific method of deposition using Applicant's claimed methylsilane, the deposited film is $(CH_3)_XSiO_Y$, which would stay "substantially as $(CH_3)_XSiO_Y$" according to the teachings in **Yau** and by Applicant.

Regarding claims 117-121, although the time is not exactly as claimed by Applicant, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See In re Huang, 40 USPQ2d 1685, 1688(Fed. Cir. 1996). In the instant case, there exists no evidence of record to indicate that some unexpected result arises from the claimed time range relative to that in the applied art. It would have been obvious for one of ordinary skill in the art, at the time of the invention to use a shorter exposure time than in **Morita** since the dielectric layer formed by **Yau** is already porous and oxidized by the method of deposition rather than being a solid mass formed by a spin-on

technique. The choice of exact time is an obvious matter of routine optimization to provide the best dielectric layer with the lowest reasonable dielectric constant.

Regarding claim 124 and 131, as noted above, the insulative layer may be an interlayer dielectric.

Regarding claims 126-128, 133, and 134, the **Yau** deposited dielectric layer is deposited with a dielectric constant of 2.5, as noted above. It is held absent evidence to the contrary that the dielectric constant is reduced by at least 10% or about 15% by exposure to the oxygen plasma and that the dielectric constant is inherently stabilized. If it is thought for some reason that the dielectric constant is not reduced or is not stabilized by exposure to the oxygen plasma, then these may be a difference. But, it has been held, where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on. (See MPEP 2112.) Given the similarity (if not equality) of the dielectric materials formed, the present evidence indicates that the dielectric constant must necessarily be reduced and stabilized.

10. Claim 111 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Yau** in view of **Morita**, as applied to claims **102**-110, 112-124, 126-128 above, and in further view of **Miyasaka** (US 6,017,779).

The prior art as explained above discloses all of the limitations of the claimed invention except for (1) depositing the $(CH_3)_xSiO_y$ layer and exposing in the same chamber is not taught

(Applicant's claims 8 and 34); and (2) shutting off the silicon process gas and maintaining conditions in the chamber to expose the dielectric to the oxygen plasma is not taught (Applicant's claim 35).

Miyasaka teaches a method of forming a silicon oxide layer on a semiconductor device using plasma-enhanced CVD with silicon-containing compound and a oxygen-containing gas and then shutting off the silicon-containing precursor and then exposing to the oxygen plasma in the same chamber maintained at sub-atmospheric pressure. (See **Miyasaka**, column 44, "Example 6" especially lines 35-52.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify either of **Yau** in view of **Morita** to maintain a device in a single chamber as taught by **Miyasaka** in order to beneficially prevent contamination to the semiconductor device dielectric layer between process steps, as is well known in the art to do, and furthermore, because it would simplify the process dramatically by preventing a switch in chambers.

Response to Arguments

11. Applicant's arguments filed 14 April 2003 have been fully considered but they are not persuasive.

Applicant argues that "Examiner depends on two inherency arguments that cannot be sustained and therefore the obviousness rejection fails." Applicant also argued that Examiner did not provide a basis in fact for the inherency. Examiner respectfully disagrees. Examiner made no such reliance. While the dielectric constant of the Morita dielectric layer being initially less than 3.5 is factual, it is not relied upon. Yau provides this feature. Rather Morita was applied to show

that one of ordinary skill has the expressed motivation to oxygen plasma treat an alkyl-containing silicon oxide thin film to improve adhesion of overlying layers. The evidence relied upon to demonstrate that the dielectric constant is reduced is Applicant's admissions on the record. The instant specification indicates that oxygen plasma treatment of a dielectric layer formed of methyl-containing silicon oxide reduces the dielectric constant. (See instant specification p. 10, line 16, p. 12, line 14.) As additional support, the reasoning stated in the rejection above regarding incorporation of space into the Morita dielectric is incorporated here.

Nonetheless, for evidence that an alkyl-containing silicon oxide thin film has a dielectric constant of less than 3.5 prior to plasma treatment, see any of the following: (1) the instant specification p. 2, line 5 to p. 3, line 8; (2) the applied reference of Yau at col. 5, lines 34-41; or (3) US 6,001,747 (Annapragada) at col. 2, lines 1-9. Examiner will certainly entertain any evidence provided by Applicant that a methyl-doped silicon oxide can somehow have a dielectric constant greater than 3.5. Given Applicant's disclosure in the specification, however, it is unclear how Applicant can suggest that the Morita insulating layer could have a dielectric constant greater than 3.5, when Applicant clearly recognizes the methyl-containing dielectrics have a dielectric constant of "about 3." Accordingly, Applicant is clearly aware of the fact that Morita dielectric layer necessarily has a dielectric constant of less than 3.5.

Applicant argues that the Morita plasma treatment would increase the dielectric constant because of the removal the methyl groups converting the alkyl-containing silicon oxide to silicon oxide and that silicon oxide has a dielectric constant of 4. Examiner respectfully asserts that this is in error. While fully dense silicon oxide has a dielectric constant of around 4, porous silicon dioxide does not. Morita states that the methyl groups are removed and the temperature is far too

low (450 °C) to allow reflow of the silicon oxide layer (>900 °C). (See Wolf, et al. Silicon Processing for the VLSI Era, Vol. 1-Process Technology, Lattice Press: Sunset Beach CA, 1986, pp. 189-190 for verification of the reflow temperature.) Moreover, Morita specifically shows that the planarity of the plasma-treated layer does not change which it would otherwise have to if reflow were to occur. Accordingly, space is left behind which has the lowest dielectric of any material. Incorporating space necessarily reduces the overall dielectric constant of the layer. This was pointed out previous. (See also Havemann, US 5,461,003, col. 2, lines 36-51 for further verification that incorporating pores/space into a dielectric will necessarily reduce the dielectric constant of the dielectric layer.)

Accordingly, Examiner did, in fact, provide a basis for making the inherency rejection as required and as elaborated upon above. Applicant, to the contrary, has failed to come forward with evidence contrary to the facts presently of record. Rather, Applicant has provided only speculation and argument that Examiner is wrong. MPEP 2145 states that "argument does not replace evidence where evidence is necessary."

Applicant argues that Examiner stated that the inherent lowering of the dielectric constant was a statement of motivation to combine Yau with Morita. This is grossly in error. The action of 23 October 2002 states, as repeated above,

> "**Morita** teaches that the oxygen plasma treatment solves the problem of poor insulation of the upper portion of organic spin-on glasses by removing the excess organic moieties at the surface, while beneficially preserving adhesion to the underlying layers by leaving the organic moieties in the lower portion of the film. (See translation provided by Applicant, section entitled "FUNCTION" beginning on p. 3.)
>
> Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Yau** to carry out the plasma treatment in **Morita** for the reasons just indicated in **Morita** for carrying out the plasma treatment."

As can be seen in the excerpt, there is no statement suggesting that one of ordinary skill would combine Morita with Yau for the purpose of reducing the dielectric constant. Rather the reasons is as stated above. However, it is noted, the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

Applicant further argues Examiner's use of the instant specification to support the inherency is in error. Examiner respectfully disagrees. A fact is a fact, it does not matter what the source is for a showing of inherency. Further in this regard, it has been held that the claiming of a new use, new function or unknown property, which is inherently present in the prior art, does not necessarily make the claim patentable. See *In re Best*, 562 F.2d 1252, 1254, 195 USPQ 430, 433 (CCPA 1977). In this case, whether or not Morita recognizes that the dielectric constant of the dielectric layer is reduced is irrelevant, since this inherently happens, as admitted to by Applicant in the instant disclosure.

Moreover, the case law cited in support of Applicant's argument is incorrectly applied here. *W. L. Gore & Associates, Inc. v Garlock, Inc.* is directed to using hindsight reasoning for combining references in a rejection under 35 USC 103(a). Examiner very clearly did not do this, as noted above. The reason for combining Yau with Morita was as just stated above in the excerpt from the rejection. This case law is not directed to the Office's use of Applicant's admissions of fact to support an inherency argument.

While Examiner acknowledges that Applicant indicates that the initialed copy of the IDS of 3 September 2002 was not received, Examiner notes that it was mailed as is clear from the

cover sheet. Examiner apologizes for any inconvenience to Applicant for not having received it. Perhaps this is because the final rejection had to be mailed twice, and the initialed copy may not mailed with the second mailing. The IDS statement will be re-mailed with the instant action and the latest IDS statements will be considered.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Erik Kielin
June 6, 2003